



A comprehensive approach to measuring the relation between systemic risk exposure and sovereign debt



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ABSTRACT

Using an integrated model to control for simultaneity, as well as new risk measurement techniques such as Adapted Exposure CoVaR and Marginal Expected Shortfall (MES), we show that the aggregate systemic risk exposure of financial institutions is positively related to sovereign debt yields in European countries in an episodic manner, varying positively with the intensity of the financial crisis facing a particular nation. We find evidence of a simultaneous relation between systemic risk exposure and sovereign debt yields. This suggests that models of sovereign debt yields should also include the systemic risk of a country's financial system in order to avoid potentially important mis-specification errors. We find evidence that systemic risk of a country's financial institutions and the risk of sovereign governments are inter-related and shocks to these domestic linkages are stronger and longer lasting than international risk spillovers. Thus, the channel in which domestic sovereign debt yields can be affected by another nation's sovereign debt is mostly an indirect one in that shocks to a foreign country's government finances are transmitted to that country's financial system which, in turn, can spill over to the domestic financial system and, ultimately, have a destabilizing effect on the domestic sovereign debt market.

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1. Introduction

The recent European crisis is fundamentally a sovereign debt crisis in which the governments of developed countries neared default. The crisis affected many of the European Union countries, several of which are bound together by the same currency (Hoffmann, 2013). As the 2007–2009 US financial crisis has shown, problems in one market (e.g., subprime mortgages) can quickly

create negative spillover effects to financial institutions and nations that were not thought to be closely related. These spillover effects can lead to sudden, sharp spikes in a financial system's overall risk, commonly referred to as systemic risk.¹ Several studies show that contagion and/or spillover exists during crisis periods (e.g., Bekaert et al. (2014); Beirne and Fratzscher (2013); Keiler and Eder (2013)).² Our study builds upon this literature, and is the first to use a comprehensive simultaneous system in order to show not only that international risk spillovers exist, but also to report that risk spillovers exist between governments and their domestic financial systems, both in terms of sovereign yields and

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¹ Note that recent literature such as Bekaert et al. (2014) and Beirne and Fratzscher (2013) make the distinction between spillover and contagion effects. For example, contagion occurs when a "sick" country or firm "infects" an otherwise-healthy country/firm whereas a spillover occurs when conditions within a country or firm influence another country/firm which may or may not be "healthy." In our analysis, we are primarily focused on risk spillover effects. See Duarte and Eisenbach (2015) for another perspective on risk spillovers in the context of fire sales.

² As noted in Bekaert et al. (2014), contagion can be defined as "the change in the way countries' own fundamentals or regional risk are priced during a particular period." As Boyson et al. (2010), among others, show, contagion can also occur at the firm level. However, our focus is on how firm level risk-taking can, in the aggregate, affect systemic risk exposure and sovereign debt yields at the national level.

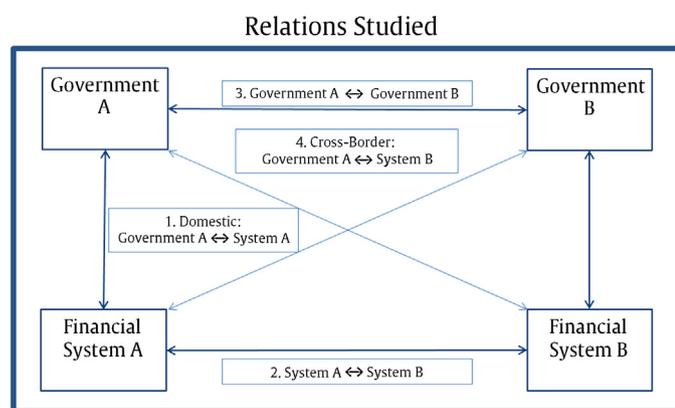


Fig. 1. Relations examined in this paper: This figure graphically presents the relations we study. Relation 1 represents the spillover of risk from financial systems to governments (and vice-versa). Some literature already examines this type of risk spillover, however, we are the first study to examine how systemic risk exposure affects sovereign yields in a simultaneous equations framework. Relation 2 examines the spillover of risk from country to country in terms of financial systems while Relation 3 examines the spillover of risk from country to country in terms of governments. Finally, Relation 4 examines how risk spills over from governments to the financial systems of other countries (and vice versa).

exposure to systemic risk.³ Moreover, we demonstrate that these spillovers occur simultaneously and thus existing sovereign debt models should include systemic risk as an important additional explanatory variable in order to avoid potential mis-specification errors.

The goal of this study is to answer four questions in a holistic manner about the relation between the risks of a nation's sovereign debt and its financial system, along with their impact on other nations' sovereign debt and financial systems. As summarized in Fig. 1, our first research question examines the inter-relationships between one country's financial system and its sovereign yield (denoted in the diagram as Relation 1 between Government A and Financial System A). Second, we study the linkage between the riskiness of one nation's financial system and another country's financial sector (referred to as Relation 2 between Financial System A and Financial System B in Fig. 1). Third, we analyze the potential relation between different nations' sovereign debt risk levels (shown as Relation 3 between Government A and Government B in the diagram). Fourth, we study the possible inter-relationships between the riskiness of one nation's financial system and another country's sovereign debt because the risks from one nation might spill over to another in an indirect manner (between one nation's financial system and another country's sovereign debt market via a "cross-market" effect as described by Relation 4 in Fig. 1).

³ There is an important distinction between *exposure* to systemic risk and *contribution* to systemic risk. Exposure to systemic risk estimates the sensitivity of a single financial institution to a negative shock within the entire financial system. In contrast, contribution to systemic risk estimates the sensitivity of the financial system to a negative shock within a single institution. We focus on the former type of risk measure in this study because systemic risk exposure is most relevant to an FI's managers and shareholders since it measures the direct impact of a systemic risk event on the FI's market value. In particular, we find that Conditional Value-at-Risk (CoVaR) and Marginal Expected Shortfall (MES) are the most direct and reliable measures of systemic risk exposure. CoVaR measures the sensitivity of bank assets to changes in the assets of the financial system while controlling for systematic risks. Marginal Expected Shortfall estimates the average bank return during the 5% worst return days of the market. These concepts are described in more detail in Section 2. See Bisias et al. (2012) for a comprehensive review of systemic risk measurement and Black et al., 2012 and Engle et al., 2014 for European-centric measures of contribution to systemic risk.

Our approach is the first comprehensive, integrated analysis of all four inter-relationships outlined in Fig. 1 whereas most existing research has primarily focused solely on one or two of these relations. For example, Relation 1 (i.e., the links between domestic FIs and a nation's sovereign debt) is the primary focus of Acharya and Steffen (2013), Beirne and Fratzscher (2013), Battistini et al. (2014), Gennaioli et al. (2014), and Acharya et al. (2016). In contrast, Kallestrup et al. (2013), Alter and Beyer (2014), Eichengreen et al. (2012), Degryse et al. (2010), among others, have explored Relation 2 (financial system spillovers). Relation 3 (sovereign debt spillovers) has been studied by Beirne and Fratzscher (2013), Caporin et al. (2015), Bai et al. (2012), Benzoni et al. (2015), Lucas et al. (2013), and Brutti and Sauré (2015). Finally, Relation 4 (cross-market international effects) has been analyzed in Kallestrup et al. (2013), Bruyckere et al. (2013), Billio et al. (2014), Gunduz and Kaya (2014), and Manzo and Picca (2015), among others. Thus, although these papers mainly focus on subsets of the risks and relations noted in Fig. 1, our study is able to test all four relations simultaneously in order to see which relations remain significant in this broader context. In particular, we find that Relation 3 is not as strong as previously thought when all four effects are estimated jointly. Thus, the channel in which domestic sovereign debt yields can be affected by another nation's sovereign debt is an indirect one in that shocks to one country's government finances are transmitted to that country's financial system which, in turn, can spill over to the domestic financial system and, ultimately, have a destabilizing effect on the domestic sovereign debt market. This indirect channel suggests that an integrated, simultaneous model is required to estimate the true effect of system risk events on financial institutions and sovereign debt in an international setting.⁴

The intuition underlying these questions is that a nation with a risky financial system may be more likely to have higher sovereign yields because investors expect the government's finances can become strained if the government is forced to bail out the nation's major FIs. That is, countries which provide a bailout to systemically distressed financial firms (or are perceived to be willing to bail out these FIs) may increase the riskiness of their own sovereign debt. Conversely, a country's financial system might grow more risky as the government's financial condition becomes weaker if these FIs are expected to purchase large amounts of the nations' (risky) sovereign debt (Gennaioli et al., 2014). Thus, the risks of both the country's government debt and financial system might be inter-related and, due to geographic and trade linkages, the risks of one nation might also spill over and affect other nations.

To test the four questions described above, we first estimate the systemic risk exposure to European-wide banking crises for each individual FI within a nation (i.e., via the CoVaR and Systemic

⁴ As noted above, there are several studies that examine a subset of the four relations but, to conserve space, we describe just a few here that are most closely related to our study. For example, Manzo and Picca (2015) used CDS data and a custom system risk contribution measure to estimate spillovers between the sovereign debt of 24 European countries and 41 large financial institutions. However, this study, as well as Kallestrup et al. (2013), relies on CDS data and does not directly examine all four types of linkages across these countries' sovereign debt and FIs. Alter and Beyer (2014) also use CDS data to study domestic and international linkages but the reliance on CDS information can be problematic because these data are more directly capturing an FI's default risk (and liquidity risk) rather than the FI's exposure to systemic risk. In contrast, we use two direct measures of systemic risk, CoVaR and MES. Billio et al. (2014) examines the interconnectedness of European sovereign and FIs using Granger causality and network analysis on a pairwise basis but does not jointly quantify the impact of all four relations that we describe in Fig. 1. Beirne and Fratzscher (2013) develop a framework for studying the linkages between sovereign debt yields within an economically integrated region and their analysis implies that international connections between systemic risk and sovereign debt might also exist (although they do not perform such tests). Lastly, Lahmann (2012) investigates some aspects of these potential intra-regional linkages, although not in as comprehensive empirical framework as we describe here.

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